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United Nations Industrial Development Organization

Symposium on Maintenance and Repair in Developing Countries
Duisburg, Federal Republic of Germany, 10 - 17 November 1970

ISSUE PAPER

SESSION III

ITEM 6 OF THE PROVISIONAL ANNOTATED AGENDA

ENGINEERING ASPECTS OF MAINTENANCE [1]

prepared by
the secretariat of UNIDO

Organized in co-operation with the German Foundation for Developing Countries and the Association of German Machinery Manufacturers (VDMA)

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Introduction.

The various aspects of maintenance are inter-dependent and none of them can accomplish its objective singly without the support of the others. Engineering activities cannot cope with maintenance problems unless they are preceded and supported by a number of other activities, such as planning, scheduling, determining level of maintenance required and other facilities. All of these measures are pre-requisites to the actual work of maintenance and repair which is the task of the engineering personnel, whether at the ordering and design stage or after production has started. Programmes such as those of repair operations, correction or replacement of parts, and details of preventive maintenance, are also their concern. At the same time, economic and organizational policies and plans cannot be implemented unless efficient engineering facilities are made available.

Some of the requirements which need examination in this context are:

a) Technical and Design Departments and centres at the enterprise level and/or at the country level;

b) Adequacy of maintenance and repair facilities to cope with modern equipment;

c) Consideration of maintenance problems in design and procurement of installations;

d) Foundry and forge shops.

a) Technical and Design Departments and centres at the enterprise level and/or at the country level.

One of the major problems facing developing countries is that of building up skills and acquiring equipment at the rate required. This problem is particularly acute in the field of maintenance and repair. Little attention has been given so far to this aspect of industrialization. In the meantime the volume of maintenance and repair work to be coped with has exceeded by far the services present facilities can render. Maintenance prevention has thus become extremely important in order to cope with this problem.

Most equipment supplied to developing countries comes from foreign firms which are not fully acquainted with local conditions. Their ability to change design and improve maintenance procedures to suit local conditions is rather limited, and their attention is directed almost entirely towards requirements of the industrialized countries. Consequently, the burden of preventive maintenance and of improving current maintenance operations, falls on the developing countries themselves. Technical offices for the study and prevention of failures through change of design of parts, change of materials or of working methods, would contribute greatly to improve maintenance conditions in these countries.

Design and technical centres represent an important part of the industrial infra-structure, not only for maintenance, but for all aspects of industrialization. Such centres exist already in many developing countries, and part of their efforts could be applied towards meeting maintenance requirements. Where such centres do not yet exist, the establishment of technical offices dealing with maintenance would be an excellent start for eventually launching such centres. Governments would be well advised to establish such central technical offices and design centres to serve industry, especially those which cannot afford to establish local offices either due to lack of funds or lack of personnel.

Such central technical offices would demonstrate the usefulness of this activity and encourage industrial enterprises to start technical offices of their own, and at the same time serve as a nucleous for future activities in this field, such as the local manufacture of spare parts. Design of spare parts and elaboration of technology for producing spare parts would be a crucial aspect of their manufacture. At a later stage, developing countries could aspire to develop their own indigenous designs and plant layouts, for which such centres would be a pre-requisite. Additionally such centres would raise the competence of developing countries to examine and select any offers made by foreign suppliers, and to propose changes and modifications to suit local conditions.

b) Adequacy of maintenance and repair facilities to cope with modern equipment.

Modern equipment with its fine tolerances and finer finishes cannot be serviced with outdated tools and by a traditional work force. Machinery today must be assembled, adjusted and attended to according to precise specifications if it is to give the expected performance. Furthermore, if proper maintenance procedures are not observed, the life span of modern equipment will be very much reduced and equipment failures are bound to occur. Up-to-date repair equipment is, therefore, essential for proper maintenance. The maintenance of adequate facilities to cope with modern equipment raises a number of problems for the developing countries which, in this respect, are at a great disadvantage as compared to industrialized nations. Enterprises in developing countries often have the services of manufacturers and suppliers at their disposal, especially for heavy and specialized repair work. Outside specialists and skilled personnel can give service at short notice. In addition, specialized repair shops are usually available to them. Such enterprises need to cope with simple day to day maintenance only. The rest can be contracted out to specialized shops or the manufacturers of equipment.

Conditions in developing countries are very different. Enterprises in these countries are located far from suppliers and assistance from them is not easily available. They cannot enlist the services of specialists from machine suppliers at short notice and, if they do, it is extremely costly. Specialized repair shops and contractors hardly exist in these countries. Under these conditions, enterprises have to cope by themselves with all their repair work. They have to establish repair facilities and sometimes heavy repair equipment which they can ill afford, and which is used for only very short periods.

One solution would be to establish central and specialized workshops which would serve major sectors of the national economy. Such central shops would do repair work which is beyond the scope or economical means of each individual enterprise. These central shops would also cope with the heavy repair work of many enterprises; thus heavy repair equipment would be more economically used and would enable central shops to employ highly skilled labour. It would be sound policy, and of substantial help to industry if developing countries were to sponsor such centres at least until such time as these centres could become self-supporting.

In this context, it should be recalled that many developing countries even find it difficult to cope with day to day maintenance. Many enterprises in developing countries are widely separated and distant from industrial centres. Mobile work shops and repair units might be considered as one of the means to meet this need. It should, however, be stressed that such mobile units would have to be specially designed to meet local conditions.

c) Consideration of maintenance problems in design and procurement of installations.

The proper choice of equipment at the ordering stage is an important factor in maintenance prevention. Most of the equipment produced in industrialized countries is designed to suit their own conditions and

not those of developing countries. Consultation and cooperation between local and technical personnel and suppliers at the procurement stage may well result in many cases in useful modifications and adaptations which would considerably reduce maintenance problems and work load.

Also, in deciding upon offers or bids submitted, preference should not always be entirely determined by the purchase price of equipment, but also take into account operating and maintenance expenses. In many developing countries, such expenses as fuel for instance, are taken into consideration while little or no attention is given to future cost of maintenance. This neglect of the maintenance aspect is costly in the long run since it is known that maintenance and repair costs of most equipment, even with proper organization, equal and, in many cases, exceed the purchase price of the equipment.

d) Foundry and forging facilities.

Lack of adequate foundry and forging facilities in many developing countries is a considerable handicap in repair work and particularly in the manufacture of spare parts.

The Symposium may wish to discuss the importance and means of establishing such facilities.

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ISSUE PAPER

SESSION I*

ITEM 7 OF THE PROVISIONAL ANNOTATED AGENDA

MANAGERIAL AND ORGANIZATIONAL ASPECTS OF MAINTENANCE 1/

prepared by
the secretariat of UNIDO

Organized in co-operation with the German Foundation of Developing Countries and the Association of German Machinery Manufacturers (VDMA)

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Introduction.

Modern management techniques are today indispensable to industry and have been recognized as such even in the developing countries. Yet in the field of repair and maintenance, such techniques are badly neglected. While, for instance, such elemental management tools as planning and control are applied to production, little attention is paid to applying such planning and control to repair and maintenance. This neglect of repair and maintenance within the industrial process has in many instances impeded the advance of industrialization in developing countries and is particularly unfortunate in view of the limited production facilities and capital such countries have at their disposal.

Surveys in developing countries show in many instances deficiences in repair and maintenance arising from poor management and faulty management decisions rather than from lack of technical experts. Perhaps too much reliance has been placed on the technical aspect of this problem at the expense of the managerial. Maintenance personnel, even those at the managerial and supervisory levels, are often competent at the technical level, while lacking modern management skills. Efficient maintenance constitutes an integral part of the production process and requires its own approach to planning and control within an industrial enterprise. Maintenance requirements in industry today, whether in developed or developing countries, can no longer be met by a "frontal attack" using physical repair facilities and technical know-how only. Many enterprises with adequate repair facilities and skills cannot cope with their maintenance problems because of lack of adequate management. Proper organization, planning and scheduling are essential for avoiding some of the repair work that is being actually carried out and for eliminating peak loads,

which lead an enterprise to build up facilities for meeting such peaks, with the corresponding waste during periods when work levels off. In addition, such planning would save on cost, skill and equipment - scarce assets in all developing countries.

The Symposium may wish to discuss the various managerial and organizational aspects of the problem, some of which are listed below, and recommend appropriate solutions. It is realized that the background papers presented to the Symposium under this item do not cover all aspects, and it is hoped that the experience of the participants will help to bring forth additional considerations bearing on this important issue during the debate.

Maintenance Organization.

Although the basic principles of organization are the same for all plants, any organization system must additionally take into account the following factors:

a) Type and size of plant: The scale of production has a marked effect on the organization to be adopted; bigger plants do require and can afford a more sophisticated system. Again a maintenance system suitable for an automobile production plant, for instance, may not be suitable for a petro-chemical plant.

b) Type of equipment: For the same type of production, the most suitable maintenance system depends on whether simple machinery or highly mechanized machinery is used.

c) Number of working shifts: A system which is suitable for a factory working one shift and having sixteen hours a day available for maintenance is different from that suitable for a factory working two or three shifts a day.

d) Types of services involved: A plant that provides its own power and steam, and supplies other services needs a different type of a set up than a plant where most services are supplied or maintained by outside bodies.

e) Type of skills available: Skills in developing countries are scarce and hard to build-up at the required rate. Rather than adopting a sophisticated system for which the required skill is unobtainable, the appropriate system to be adopted should be tailored to the potential skill available.

f) Local conditions: A plant near the machinery supplier or located where central repair shops and maintenance organizations are available needs a much simpler set up than a plant isolated from such facilities. Since these locational factors vary, there can be no fixed rules or set ups which would suit all conditions.

The determining of the appropriate organization for each enterprise is essential, particularly for smaller ones. Lack of such organization is common, but also over-organization has been known in some instances when systems used in more advanced countries have been indiscriminately copied; in other cases and, perhaps as a reaction to shortcomings resulting from past unplanned maintenance, maintenance has been over-organized to a point as to become an end by itself and not as a means to attain certain objectives. Smaller companies in particular must guard against such a mistaken approach.

Maintenance Planning.

It is impossible to cope with maintenance and repair by just waiting until a breakdown happens or a machine stops, i.e. by the "Fire-fighting technique". Maintenance work should be planned. An important phase of maintenance planning is what is known as "Preventive Maintenance".

Some enterprises report that their maintenance costs have been reduced by as much as 40 percent after about four years of introducing preventive maintenance programme, not including savings due to reduction of downtime of equipment.

Maintenance Records and Control.

A maintenance records and control system, including adequate costing, is essential for management. A well-organized system is usually achieved only after some years of continuous re-planning and re-organization based on facts and figures fed back to the system. No less essential is the availability of a costing system for deciding on whether to replace equipment or to continue repairs or when the problem of stand-by is under consideration.

Spare Parts Storage and Supply.

In many developing countries lack of spare parts is a major hindrance to efficient maintenance. While a stock of spare parts is necessary, undue over-stocking which imposes a great financial burden on an enterprise must also be avoided.

Spare parts supplies are a crucial problem for enterprises in developing countries and deserve special consideration. The Symposium may wish to discuss in detail this issue and its implications.

Upgrading and Training of Personnel.

The backbone of maintenance activities is qualified personnel; all other facilities being just tools for such personnel in attaining the required objectives. The building up of an adequate personnel force through a planned training programme both at the managerial and labour levels is the responsibility of top management. At the same time, formal training should be supplemented by giving maintenance personnel the opportunity of gaining experience on the job.

Standardization of Equipment.

Standardization of equipment simplifies enormously maintenance efforts and reduces considerably the stock of spare parts. However, such standardization is not easily achieved by developing countries which are often obliged to purchase equipment from those countries giving them loans or donations for acquiring such equipment. Also the tendering system adopted by most developing countries does not promote standardization, the aim being to obtain the best terms of purchase and not standard equipment. It should be kept in mind that standardization may also result in some suppliers monopolizing the market for years with all dangers this implies.

Contract Maintenance.

Sub-contracting maintenance and repair work to specialized firms may prove advantageous in many cases. Such sub-contracting can be particularly useful for seasonal peak jobs or for operations which need special machinery which it would be uneconomical for individual enterprises to purchase or to maintain. The planning and organization of sub-contracting arrangements requires in particular management attention.

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SESSION V

ITEM 9 ON THE PROVISIONAL ANNOTATED AGENDA

NATIONAL ACTION AND INTERNATIONAL CO-OPERATION IN IMPROVING MAINTENANCE AND REPAIR FACILITIES IN DEVELOPING COUNTRIES [1]

prepared by

the secretariat of UNIDO

Organized in co-operation with the German Foundation for Developing Countries and the Association of German Machinery Manufacturers (VDMA)

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While the principal responsibility for initiating and establishing adequate maintenance and repair facilities in developing countries should be the concern of these countries themselves, international co-operation has acquired increasing significance in this area. In this context, two major considerations should be taken into account:

a) The bulk of production equipment in developing countries is supplied and will continue to be supplied in the foreseeable future from industrialized countries. As suppliers, these countries take upon themselves certain responsibilities as regards repair and maintenance of such equipment, and thus have an important role to play in this field.

b) In the promotion of their industrial activities (including maintenance and repair) developing countries depend and will continue to depend for some time to come to a great extent on bilateral assistance from industrialized countries and multi-lateral and international co-operation with international bodies and United Nations agencies.

Given this inter-relationship of factors and the involvement of the various bodies - industrial enterprises, national and international organizations - the contribution each of these bodies can and perhaps ought to make towards improving repair and maintenance facilities in developing countries, should be closely examined. This is rather a complex subject which the Symposium may wish to discuss fully so as to put forward practical conclusions and recommendations which would enable the developing countries to derive the full benefit which bilateral and international co-operation offers in this field.

The following information and remarks may contribute to the discussions:

A) Duties and Obligations of Supplying Firms:

Before the Expert Group Meeting on Maintenance and Repair of Industrial Equipment in Developing Countries, which took place in New York from 28 November to 9 December 1966, a questionnaire was sent to many developing countries intended to obtain information on maintenance and repair activities in these countries and to assess their requirements. This was followed in 1969 by a survey of maintenance and repair facilities in 12 countries.

The terms of reference given to the experts who surveyed the 12 countries included the task of finding out "whether the services rendered by manufacturers of imported industrial equipment are satisfactory". The query had also been dealt with in one of the questionnaires. Seventy percent of the answers indicated that such services are not satisfactory. Analysis of the replies received indicated that many firms rendered reasonable service during installation and start of equipment; fewer firms gave satisfactory service during guarantee periods; and very few continued to be interested in rendering reasonable service after the guarantee period expired. Again, most assistance received from manufacturers aimed at attaining guaranteed production figures or to proving that the equipment is capable of giving the performance stipulated in the contract. Comparatively little assistance was directed towards maintenance and repair. It is well known that it is much easier to start a plant than to keep it operating economically and efficiently. The attitude of the manufacturers seems to have been that "we have delivered the equipment which is capable of producing what you want, it is up to you to keep the equipment in a condition which will allow it to continue giving such performance".

Complaints related particularly to the following aspects:

a) Operating and Maintenance Manuals and Other Technical Documents: Their availability is usually very limited and, if available, in the original language only. The text is prepared for customers in advanced countries. Such manuals are usually not suitable for the level of education, skill and experience of nationals in developing countries. An effort should be made by suppliers of machinery to make specially prepared technical documents available to developing countries in the local language.

b) Training and Personnel: This is inadequate and practically concentrated at the labour level. Shortage and skilled personnel, particularly at the management level, is a major bottle-neck in maintenance activities. Suppliers of machinery cannot usually accommodate a sufficient number of personnel for training on their premises.

c) Local Agencies: Local agencies are, as a rule, not properly equipped and do not have competent personnel to look after maintenance problems. It is generally agreed that better service is usually obtained from suppliers or their local office, if the latter is a part of the supplier organization, than from local agencies.

d) Assistance after Guarantee Periods: Apart from large reputable firms, most suppliers lose interest after the guarantee period expires.

Experience indicates that such complaints are justified; however, whether these shortcomings are entirely the responsibility of supplying firms is debatable. This point will be amplified in the next chapter.

B) Role of Governments of Industrialized Countries:

Donations, long-term loans and technical assistance are being given by many industrialized countries to developing nations. While it is outside the scope of this Symposium to discuss whether the magnitude of the help is satisfactory, the meeting offers an opportunity to discuss whether the assistance given could be directed towards specific areas, e.g. repair and maintenance, where it could be more effective to promoting industrial development.

a) Obligations of supplying firms: These have been reviewed in the previous chapter. The needs as outlined are justified, but meeting these needs is costly. Most supplying firms appear to be willing to cope with these needs if reimbursed for the additional expense. These firms cannot be expected to bear the entire cost and thus reduce their margin of profit which is, in many instances, relatively small because of the tendering system adopted by most developing countries. On the other hand, many developing countries either are not willing to pay for these services or are unable to do so.

Governments of industrialized countries can help in resolving this impasse. Part of their assistance intended for the purchase of equipment from their respective countries, could be allocated, instead, to the financing of the following undertakings, either supported entirely by the governments or in cooperation with the suppliers:

1) the preparation of suitable technical manuals, etc., based on the abovementioned studies and preferably in the local language;

2) a thorough study of local conditions and the initiation of suitable maintenance techniques;

3) financial assistance in the training of a larger number of personnel on the premises of the supplying firms or other technical and training institutions;

4) supplying developing countries with a larger number of personnel during and after the guarantee period; until the ability of developing countries to maintain new equipment has reached a satisfactory standard.

Such steps would benefit both developing and industrialized countries. The industrialized countries have certainly an interest in seeing to it that equipment supplied by their firms give satisfactory service and are well maintained. This enhances the reputation of their equipment and also their foreign trade.

b) Help in establishing technical and design centres: Maintenance prevention, through change and adaptation of design to suit local working conditions is a considerable factor in meeting maintenance problems in developing countries. Establishing design and technical centres is a major step in this respect. The information and experience gained from the operation of such centres would be beneficial both to the developing and industrialized countries. The firms in industrialized countries would gain experience and know-how, to modify their products, wherever possible, to local conditions.

Although the responsibility for establishing such centres lies mainly within the developing countries themselves, most of them require financial and technical assistance which could form part of the assistance industrialized countries extend to developing countries.

c) In-plant training programmes in maintenance and repair: As indicated by answers received from developing countries, one of the major obstacles to establishing adequate maintenance and repair facilities is lack of the adequate number of

qualified experienced personnel in this field. The training of such personnel is a heavy load on the developing countries. Part of the technical assistance allocation could be directed towards establishing in-plant training programmes in advanced countries, perhaps on a regional basis. Many industrialized countries have already sponsored such courses and it is hoped that other industrialized countries will follow suit.

C) Role of Developing Countries:

The primary responsibility for establishing adequate maintenance and repair facilities lies within the developing countries themselves. The assistance received from industrialized countries and international agencies would be of little value unless the developing countries themselves establish their own programmes of action and regard outside assistance as only a help in implementing such programmes. At the same time the developing countries must also build up their indigenous capacity to absorb such help as is extended to them.

The role of developing countries comes under two main categories, that of government and that of enterprises:

a) Role of Government. One of the main reasons for lack of adequate maintenance and repair facilities in developing countries is the lack of understanding and appreciation of the essential role these facilities play in the industrialization process. The building up of an adequate background and consciousness in this area is of utmost importance. In most developing countries government guidance and support to create and maintain a proper awareness is essential. To this end, governments should initiate some of the following:

1) Maintenance should be part of the general planning of industrial development.
2) The establishment of design centres and technical offices at the country level and

the enterprise level should be encouraged. Particularly at early stages of industrial development, the government should establish such central design centres; and, later, for each sector. Financial and technical assistance should also be given to enterprises in establishing their own technical offices.

3) The Government should provide financial, fiscal, and other incentives to induce industry to establish adequate maintenance and repair facilities, rational maintenance policies and adequate training facilities.

4) Since lack of spare parts is a major problem in most developing countries, the Government should formulate a rational import policy for spare parts. Additional measures would include the introduction of efficient custom clearing procedures and the establishment of duty-free zones to ease the financial burden on enterprises.

5) Arrangements for assisting enterprises to obtain and dissemenate information on maintenance and repair, including the establishment of technical libraries and information centres, the holding of seminars, etc.

6) The establishment of spare parts manufacturing centres. In ad ition to reducing the drain on foreign exchange, such centres would, in the long run, add materially to the country's ability to promote industrial development. The operation of such centres would contribute to the creation of a pool of skills and experience which could serve other ancillary industries.

b) Role of Industry and Industrial Enterprises: Industry and industrial enterprises have a primary role to play in establishing maintenance and repair facilities. Foreign suppliers, governments of industrialized countries, and local governments, may help in varying degrees, but the principal task lies within industry itself.

It is its duty to safeguard this valuable capital asset and to ensure that these facilities will contribute to industrial development. Industry should recognize efficient maintenance as an important industrial function, train maintenance personnel, encourage know-how, and provide the proper tools and spare parts.

c) Role of UNIDO: What UNIDO is doing and can do is explained in the background paper "UNIDO's Campaign in Improving Maintenance and Repair in Developing Countries". However, the ultimate aim of UNIDO's activities is to assist developing countries to overcome their difficulties and to develop their facilities to meet their requirements in the field of repair and maintenance.

The Symposium offers perhaps a unique opportunity for the developing countries to express their problems, needs and aspirations; and for UNIDO to examine these requirements and determine the extent to which it can assist in resolving these issues.